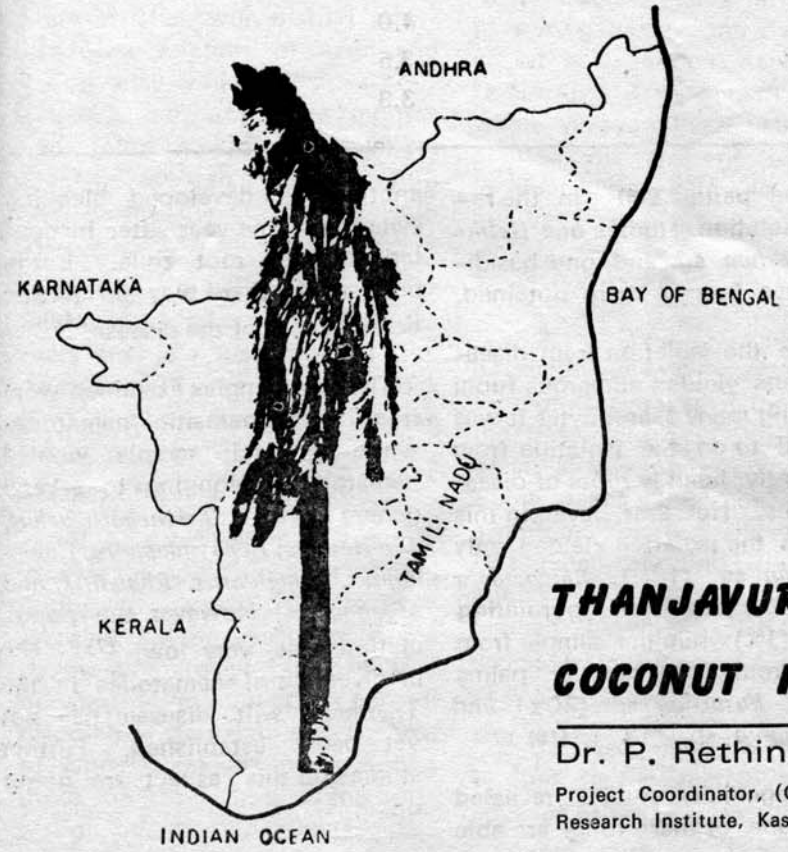

THANJAVUR WILT DISEASE OF COCONUT IN TAMIL NADU

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Of all the plants cultivated by man, the coconut palm is the most useful one. It is known as "Tree of Life' or 'Tree of Heaven' or 'Kalpavriksha'. India with 1.1 million ha under coconut, ranks third in the world area and production. Kerala, Karnataka and Tamil Nadu accounts for more than 90% of the area under coconut in India.

Among all the cultivated plants, coconut is affected by more number of disease of unknown / uncertain etiology. India has at least four of them namely, Root (wilt) disease of Kerala, Thanjavur wilt of Tamil Nadu, Thatipaka of Andhra Pradesh and Stem bleeding disease present throughout the peninsular India.

1. Occurrence of Thanjavur Wilt Disease

Thanjavur wilt disease of coconut though endemic in the coastal areas attracted the attention of the growers and scientists only after the cyclone of 1952 and 1955 in Thanjavur district where the intensity of the disease was

severe.[22] Hence it was named as Thanjavur wilt disease.

2. Distribution of Disease

Though the disease was originally located in Thanjavur district the survey conducted during the year 1965 - 66 in the different districts of Tamil Nadu revealed that the incidence ranged between 3.3% and 10.8%.

Table : 1. Percentage of incidence in different districts (1965-66)

District	% Disease incidence
Thanjavur	10.8
Kanyakumari	6.3
Trichirappalli and Ramanathapuram	4.0
South Arcot	3.5
Chinglepet	3.3

The disease has slowly spread from the coastal districts to interior districts of Tamil Nadu. Now the disease is seen in almost all the districts of Tamil Nadu. Though a statistical survey was organised in 1978 to assess the incidence and severity of the disease, survey could be done only in eight districts. As per the survey disease incidence ranges from 2.6 to 13.5% in different districts. The survey is yet to be completed. However, a comprehensive survey has not been conducted so far to assess the real situation of the extent of damage caused by this disease. [18]

3. Etiology

The exact cause of the disease still remains uncertain. From the evidences available so far, it appears to be complex in which the fungus *Ganoderma lucidum* (Leyss, Karst is also involved. Apart from this, *Rhizoctonia* sp., *Fusarium* sp. *Diplodia* sp., *Ceratostomella* sp, and *Trichoderma* sp. were also isolated from diseased parts [18]. In the recent isolation studies one *Helminthosporium* sp. and one basidiomycetes fungus were obtained.

Since the isolation from diseased roots yielded numerous fungi including many saprophytes it was decided to do the isolation from apparantly healthy roots of diseased trees. However, even in this method the isolation yielded only *Fusarium* sp. (18%), *Rhizoctonia* sp. (14%) and non sporulating fungus (1%) while the sample from the surrounding healthy palms yielded *Fusarium* sp. (20%) and *Rhizoctonia* sp. (12%). [18]

Pathogenicity studies revealed that none of these fungi are able to produce any symptom on healthy coconut seedlings and 25 year old adult palms even after 2 years when they were artificially inoculated in the root zone and injected into the trunk except in two cases viz. (1) one palm developed bleeding symptom eight months after inoculation with *G. lucidum* in the root zone combined with injection of juice obtaind from diseased palm (ii) another palm developed bleeding symptoms one year after incoculation in the root zone. But in both cases there was no further development of the disease.[18]

The root samples examined were free from parasitic nematodes while the soil sample yielded nematodes belonging to several genera viz. *Tylenchorhynchus, Dorylaimus, Ecphyadophora, Hoplolaimus, Longidorus, Rhabditis,* and *Mononchus.* However, the popu-ulation was very low. [7] The involvement of nematodes in the Thanjavur wilt disease has not yet been established. Further studies on this aspect are going on.

It is possible that the trees are weakened due to adverse soil and environmental conditions which might result in non - functioning and decay of the root system and finally the fungi and insects invade. The etiology of this study still remains to be uncertain.

4. Epidemiology

I. Soil Conditions : Generally the disease is more prevalent

in coastal sandy or sandy loam soils where coconut is grown under rainfed conditions and when much attention is not paid to the coconut culture. Lack of soil moisture during summer months, water logging in rainy season, presence of old infections in the garden and neglect of cultural operations were found to be conducive to the spread of the disease. Sub-soil in the diseased areas of Thanjavur district consists of a mixture of sand and yellow clay which hardens considerably during summer months and forms a hard pan impeding root penetration which in turn predisposes the coconut trees to infection. (1, 17, 22)

(ii) **Age of the palm** : Trees in the age group of 10 to 30 years are more susceptible to the disease (43%) than younger trees (17%). Some trees survive the initial attack and live for a number of years. (1, 17, 22,)

(iii) **Weather factors** : Observations on the epidemiology recorded during the years 1971 to 1976 revealed that the disease incidence is more between the months of March and August; in general bleeding symptoms and number of wilted trees are more during these months. There is no correlation among minimum temperature, rainfall and relative humidity. However, a positive correlation was observed between the mean maximum temperature and number of bleeding palms. (3, 16, 17, 22) Stem bleeding occurs mostly during the rainy seasons and death occurs during summer. (22) The severity of the disease during July - October (2) as well as March - September (3) was also reported.

(iv) **Spread in infected gardens** : The spread of the disease is rapid in infected gardens. The annual rate of spread was from 0.2 to 4.8% and intensity was from 0.8 to 25.6%. (22) In some of the severely infected gardens in Muthupet and Pattukottai blocks of Thanjavur district the disease has been noticed up to 30%. (10) The disease appears to spread from particular foci of infection. (2) In two gardens, one near Chinglepet and another near Kulasekaram in Kanyakumari district where Malayan dwarf yellow were planted on a large scale, the incidence is very severe and hundreds of palms have died.

5. Symptomatology

1. **Stem** : Wilting of palms may be accompanied by stem bleeding through the cracks of the stem at the base (Fig. 1). This bleeding patch slowly goes up (Fig. 2). Some palms show only wilting symptoms without any bleeding in the stem and they die in due course In palms that bleed, a reddish brown viscous fluid is exuded from the peripheral tissues of the basal protions of the stem and such patches extend upwards to four to five metres with the advance of the disease. This discoloured core of the stem is confined to the height at which active bleeding occurs. In the final stages of the disease the basal portion of the stem gets decayed and discoloured. Affected tissues are lighter in colour. Fructifications of the bracket fungus *Ganoderma lucidum* occur in a few cases on the trunks of wilted trees just above the soil level. (1, 14, 22)

2. **Leaves** : The outer one or two whorls of leaves change in colour from green to dull yellow and they droop down. (Fig. 3) Later they wither and then subsequent whorls also droop down in quick succession as disease advances until the spindle alone remains (Fig.4&5). Under prolonged infection, the outer leaves fall away and subsequent ones get reduced in size with shortened spindle that does not unfold properly. A soft rot sets in the bud in certain cases, resulting in loss of turgidity and death of cells due to breakdown of conducting elements. The affected bud emits a bad smell and in advanced stages the spindle gets blown off leaving the decapitated stem (Fig. 6.). (11, 14, 22)

3. **Flowers** : Normal production of inflorescences gets suspended with the rapid development of disease symptoms. The palms become barren. When the disease is less acute and slow in progress there is no button shedding. As the leaves droop down, the subtended bunches also hang down. Even the nuts that develop are without kernels. Where the disease progress is slow, only a few normal nuts are produced and in fact most of the palms bear profusely just prior to and at the time of initiation of symptoms. (1, 14, 22)

4. **Roots** : Extensive rotting and discolouration of root system and fewer secondary and tertiary roots, discolouration of primary and secondary roots, are characteristic symptoms of the disease. The roots are watery with a distinct alcoholic smell and appear reddened below

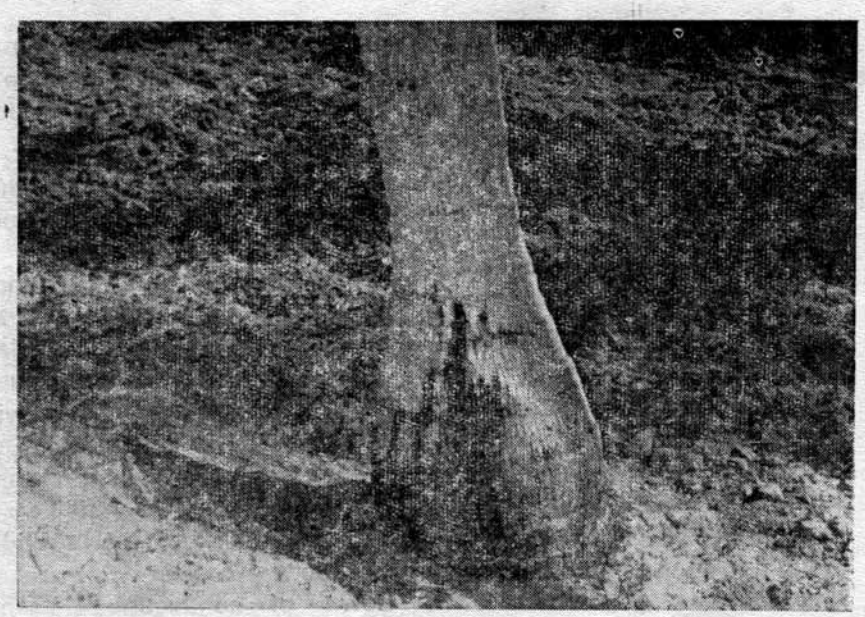

Fig. 1. Bleeding through cracks in the stem at the base

the hypodermis and brownish towards stele. Cortical tissue disintegrates and the stele turns brown. New roots are hardly produced after the tree develops external symptoms of the disease. These appears to have a die-back effect on the roots with progressive reduction in number of new roots produced. (1,22).

Five distinct stages in the progress of Thanjavur wilt disease can be recognised as follows:

1) Decay and death of the fine roots, then main roots, light bronzing of lowest leaf whorl and partial folding of leaf-lets.

2) Flaccidity of spindle leaves intense bronzing of outer leaves, unproductive inflorescence with arrested fruit set, root decay extending to bole region.

3) Decay extends into stem bleeding patches that appear on basal part of the trunk, outer 1–2 whorls of leaves droop down, resulting in their bunches hanging down, spindle shorter and erect without unfolding properly.

4) Internal stem decay extends up to middle region, bleeding patches increases, outer leaves drop away and crown gets reduced in size due to a few undersized pale green leaves.

5) Plam dries up with the spindle and can easily be uprooted, or the top gets usually blown off and stem gets shrivelled and dried up.

The time taken for the progress of the disease up to the appearance of bleeding symptoms ie. stages 1 and 2 could not be determined.

Stages 3, 4 and 5 last from 6 to 54 months, the average being 24 months. Where death occurs in 6 months stage 4 is absent. In stage 3, 4 and 5 *Xyleborus* is usually found boring into stem at the bleeding patches. In certain cases *Scolytid* beetles and *Diocalendra* weevils attack and aggrevate the disease, causing rapid death. (1, 22)

Though bleeding is common in stem bleeding, Thanjavur wilt of Tamil Nadu, Ganoderma wilt of Karnataka and Andhra Pradesh there are certain basic differences among these diseases. Though Ganoderma wilt of Andhra Pradesh resembles the Thanjavur wilt

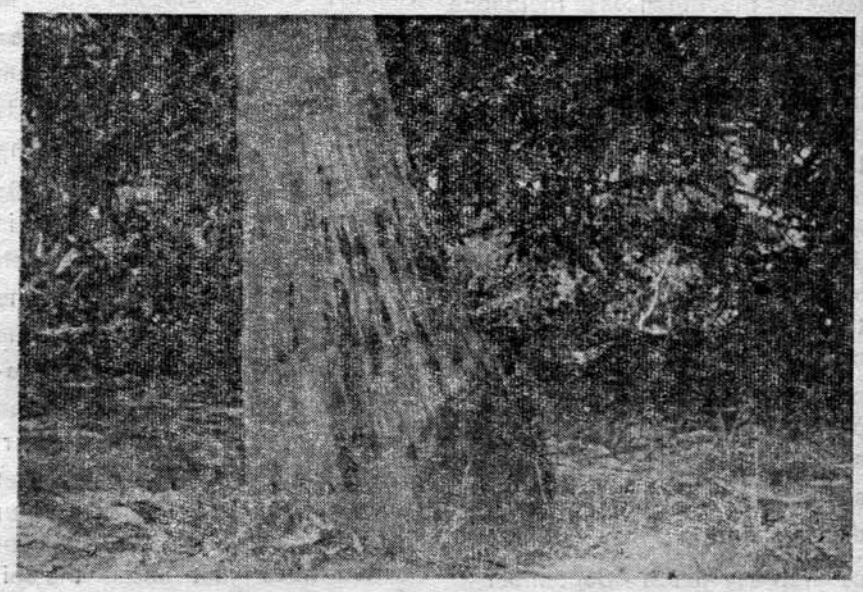

Fig. 2. Bleeding slowly progresses upwards

in many external symptoms, it differs in the absence of rotting of bole and stem. The presence of bleeding patches on the stem is a typical symptom of Thanjavur wilt and is very much similar to Ganoderma wilt of Karnataka. However, the role of *Ganoderma lucidum* as the chief incident of the disease is to be viewed with some reservation as far as Thanjavur wilt is concerned. (22)

6. Control Measures

Under the scheme for the investigation of coconut wilt disease in Tamil Nadu started during 1965, a series of cultural, manurial and chemical trials were laid out at Mutupet, Thambikottai and Veppankulam villages of Thanjavur district. From 1972 onwards these studies were continued under All India Coordinated Coconut and Arecanut Improvement Project. The wilt scheme with the state fund was also carried out at Nagarcoil in Kanyakumari district. The result of the various studies are given below.

Fig. 3. Outer whorl of leaves change in colour and droop

(i) Effect of fertilizers :The earlier trial conducted from the year 1965 to 1970 showed that the fertilizer dose of 0.23 kg each of N & P_2O_5 and 0.34 kg K_2O/palm/year did not have any significant effect on disease intensity while application of double the dose of fertilizers increased the intensity of disease. Similarly, another trial conducted from 1978 onwards showed that the treatment with 0.35, 0.25 and 0.45 kg N, P_2O_5 and K_2O / palm / year respectively had low disease index and high nut yield.

Higher dose of fertilizers in both the trials had increased the disease intensity. (5, 6, 7, 13, 18, 22)

(ii) Effect of soil amendments and organic manures :

The ameliorative effect of soil amendments was studied from 1972 to 1976 using gypsum (20 kg), sulphur (1kg,) molasses (10 kg), paddy husk (60 kg), lime (2kg) and neem cake (5 kg) + green leaves (50 kg). The results have indicated that the neem cake treatment had reduced the disease intensity to a considerable extent when compared to control. (5,6,18)

The effect of coconut husk burial (500 nos./palm) around the adult palm had considerably decreased the disease intensity but has not influenced the nut yield. (18) The application of farmyard manure (200 kg/palm), green leaves (50 kg/palm), tank silt (300 kg/palm) and neem cake (5 kg palm) alone or in combination with soil drenching of 1% Bordeaux mixture thrice a year had reduced the intensity and

Fig. 4. Subsequent whorls also droop at quick successions

increased the nut yield. Application of neem cake alone and in combination with drenching Bordeaux mixture were most effective in reducing the intensity of the disease. (5, 7, 13, 18) The study on the effect of tank silt (100 kg) + green leaf (50kg) and farmyard manure (250 kg) + wood ash (20 kg/palm) conducted for 5 years had revealed that the disease index was considerably low in these plots compared to control. (18)

(iii) Effect of irrigation : Irrigation alone was not effective. Irrigation with fertilizer application increased the disease intensity. Irrigation combined with Bordeaux mixture checked the disease intensity considerably, compared to control and other treatments. Organic manure with irrigation also ameliorated the disease symptoms to certain extent. Irrigation along with farmyard manure + coconut husk and Bordeaux mixture was superior in reducing the intensity of the disease. (3,4,18)

Fig. 5. Advanced stage of disease where spindle alone is alive

(iv) Combined effect of manures, fertilizers and chemicals : The combined effect of addition of NPK, copper sulphate, lime, neem cake, green leaves and coconut husks had increased the yields but did not reduce the disease intensity. In another study the combined application of Bordeaux mixture, tank silt and green manures reduced the disease intensity; tank silt and green manure reduced the disease intensity considerably.[18] In general, organic matter had reduced the intensity of the disease.

(v) Effect of micronutrients :

Application of 227 g. either of manganese sulphate or borax was found to reduce the intensity of the disease. [2, 14] The disease intensity was the highest in palms that received molybdenum.[2] From the trials conducted during 1981, it was reported that the application of micronutrients viz. borax, zinc sulphate, manganese sulphate, and magnesium sulphate has no direct effect in checking the spread of the disease. But the trials have shown that when these micronutrients were applied along with the fungicides marked reduction in the disease intensity could be observed. [19] The role of micronutrients needs further detailed study before arriving at any conclusion.

(vi) Effect of fungicides and other chemicals :

The fungicidal trials conducted between 1965 and 1969 revealed that drenching of 40 litres of Bordeaux mixture was effective when compared to fytolon + BHC and tar application. Studies conducted from 1969 to 1973 indicated that the application of Bordeaux mixture during cold weather (Oct-Jan) was also effective in reducing the intensity of the disease. [3, 4, 6, 8, 18,]

The field trials conducted with systemic fungicides and antibiotics from 1972 to 1976 indicated that aureofunginsol (0.2%) was very effective in reducing the intensity of the disease. [2, 3] Subsequently, a study was carried out using the systemic fungicides viz. Auerofunginsol, Bavistin, Benlate and Vitavax (1g in 500 ml water) as stem injection. The results indicated that aureofungin-sol stem injection + Bordeaux mixture 40 litres of 1% solution drenching were effective in the control of Thanjavur wilt disease. The yield was also more in this treatment. [5, 7, 15, 18] Application of 0.1% benelate at 10 litre/palm as drenching after exposing the roots also gave good control. [15] The trials conducted from 1977 using the systemic fungicides as soil drench also showed that aureofungin sol + Bordeaux mixture was effective in reducing the intensity of the disease. [18] A 3 year study using fungicides showed that captan, thiram and cuman recorded lesser percentage of mortality. Soil application of sulphur dust at 1.5 kg per palm did not show any mortality even after a period of three years. [16] However, the trial conducted at Muthupet showed application of sulphur had recorded higher percentage of infection. [2] By and large the studies conducted so far have clearly indicated that drenching of Bordeaux mixture 1% solution at 40 litres / palm once in three months recorded low intensity of disease. The stem injection studies showed that 2g aureofungin sol + 1g. copper sulphate in 100 ml water reduced the intensity of the disease.

The studies with (i) the stem treatment with tar followed by drenching with either BHC 0.2%

Fig. 6. The spindle gets blown off leaving decapitated stem

or DDT 0.2% or common salt, application of zinc white or SANTAR–A on the stem, (ii) stem treatment with tar followed by the application of either cheshunt compound or magnesium sulphate (454 g) to soil, injecting the stem with pyrocone E (100ml). Paradichloro benzene (25g) and neem oil (25 ml) did not reduce the disease intensity. [18]

Since the association of the scolytid beetle *Xyleborus* sp. was also noticed in some wilt affected coconut palm, a field trial using dieldrex, heptachlor, chlordane, C. L dust and sulphur dust was conducted from 1966 to 1969. The results indicated that the heptachlor treated palms showed minimum disease intensity. [18] Stem injection of Nuvacron 2.5 ml in 100 ml water recorded low disease intensity. [8]

7. Management of Thanjavur Wilt Disease

From the studies conducted at Coconut Research Station, Veppankulam under the coconut wilt schemes as well as under the All India Coordinated Coconut and Arecanut Improvement Project the following management practices are being suggested:

(1) Increasing the soil organic matter level by addition of farmyard manure, green leaves, tank silt etc.

(2) Addition of 5 kg neem cake/palm/year over and above the normal fertilizer dose.

(3) Regular irrigation during summer months and conserving the soil moisture with the addition of mulches.

(4) Soil drenching with 40 litres of 1% Bordeaux mixture thrice a year for one year or stem injection of aureofungin sol, 2 gm + 1g copper sulphate in 100 ml water thrice a year for one year. If stem injection is given the hole should be at 45 angle with 5 mm diameter and 10 cm depth. After treatment the hole should be plugged with clay mixed with any fungicide and later by cement. The above suggested treament is applicable only to the palms which are in the early stages of disease.

(5) Taking trenches all around the diseased palm and separating it from healthy palms.

(6) If *Xyleborus* attack is noticed in the stems of affected palms smearing with BHC or heptachlor has to be done.

(7) Palm to palm irrigation should be avoided. This type of irrigation will help in the rapid spread of the disease to the adjacent palms. Irrigation channel should be separate

(8) If the palms die due to Thanjavur wilt disease the palm should be cut and removed. The boles and the rot bits should be burnt in the pit itself.

Considering the importance of the three complex diseases viz. Thanjavur wilt, Ganoderma wilt and Stem bleeding a collaborative project involving the scientists from All India Coordinated Coconut and Arecanut Improvement Project, Central Plantation Crops Research Institute, Kerala Agricultural University, Tamil Nadu Agricultural University, University of Agricultural Sciences Karnataka and Andhra Pradesh Agricultural, University has been formulated during the year 1983 and all aspects of these diseases are being studied including the varietal screening and development of management practices.

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